

CLAIMS

1. A method of estimating the effective bandwidth at a node in a communications network comprising:-

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identifying a type of traffic flow off-line;

measuring an effective bandwidth and a mean rate of traffic flow of the identified type of traffic flow;

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defining a relationship between the effective bandwidth and the mean rate of traffic flow for the identified type of traffic flow;

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storing a database of relationships for different identifiable types of traffic flows off-line;

identifying a type of traffic flow on-line at the node;

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measuring the mean rate of traffic flow of the identified type of traffic flow on-line;

comparing the identified type of traffic flow on-line to a similar identified type of traffic flow off-line to obtain a relationship from the database of relationships;

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estimating an effective bandwidth of the identified type of traffic flow on-line at the node from the mean rate of traffic flow measured from the identified traffic flow on-line and the relationship obtained from the similar identified type of traffic flow off-line.

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2. A method of estimating the effective bandwidth at a node in a communications network as claimed in claim 1 comprising the further steps of:-

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measuring the mean rate of traffic flow individually on-line for a number of identifiable types of traffic flows forming a traffic aggregate;

5 individually comparing each type of identified traffic flow on-line to a similar type of traffic flow off-line to obtain a relationship from the database of relationships for each type of identified traffic flow on-line;

estimating the effective bandwidth on-line at the node for the number of identifiable types of traffic flow.

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3. A method of estimating the effective bandwidth at a node as claimed in claim 2, in which the method further comprises the step of:-

15 identifying a traffic aggregate on-line which represents traffic produced by a group of flows of the same type.

4. A method of estimating the effective bandwidth as claimed in any preceding claim wherein the method further comprises the step of:-

20 updating the database of relationships with a relationship from the estimated effective bandwidth and the mean rate on-line value.

5. A method of estimating the effective bandwidth as claimed in any preceding claim in which the step of obtaining the effective bandwidth off-line takes
25 account of quality of service requirements in the communications network.

6. A method of estimating the effective bandwidth as claimed in any preceding claim in which the steps of obtaining the effective bandwidth off-line incorporates a loss ratio or delay parameter in the communications network.

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7. A method of estimating the effective bandwidth as claimed in any preceding claim in which the step of calculating the relationship between the effective bandwidth and the mean rate of traffic flow is calculated off-line over a number of time intervals.

8. A method of estimating the effective bandwidth as claimed in any preceding claim wherein the step of measuring the mean rate of traffic flow comprises measuring the number of packets of information at the node on-line.

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9. A method of estimating the effective bandwidth as claimed in any preceding claim, wherein the relationship between the effective bandwidth and the mean rate of traffic flow is calculated as the ratio of the effective bandwidth with respect to the mean rate of the traffic flow.

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10. A method of estimating the effective bandwidth as claimed in any preceding claim, comprising estimating the effective bandwidth off-line and measuring the mean rate off-line for a number of flows to obtain a relationship represented by:-

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$$C_i = \frac{E_i}{m_i} \quad i = 1, \dots, N$$

where

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C_i = ratio for the i-th flow

E_i = Effective bandwidth the for i-th flow measured off-line

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m_i = Mean rate of traffic flow for the i-th flow measured off-line

N = Number of different traffic flows.

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11. A method of estimating the effective bandwidth as claimed in claim 10, comprising estimating the ratio C for a number of traffic flows off-line represented by:-

$$C = (C_1 + \dots + C_N) / N$$

12. A method of estimating the effective bandwidth as claimed in claim 10, comprising estimating the typical ratio C off-line for a number of traffic flows each flow of a particular time duration represented by:

$$C = (T_1 C_1 + \dots + T_N C_N) / (T_1 + \dots + T_N)$$

where T_i = time duration of a particular flow

N = total number of flows.

13. A method of estimating the effective bandwidth as claimed in claim 10 comprising estimating the typical ratio C off-line for a number of traffic flows each traffic flow of a particular time duration and a measured value of mean rate and effective bandwidth represented by:-

$$C = (T_1 E_1 + \dots + T_N E_N) / (T_1 m_1 + \dots + T_N m_N).$$

where T_i = time duration of a traffic flow

E_i = estimated effective bandwidth of a traffic flow

m_i = measured mean rate of a traffic flow

N_i = number of traffic flows.

14. A method of estimating the effective bandwidth as claimed in any preceding claim, comprising the further step of:-

factoring the quality of service requirements into the estimation of bandwidth by calculating the maximum number of flows to maintain quality of service requirements by:-

$$\text{Prob} \{mC_1 + \dots + mC_N > B\} < P$$

wherein

m = measured mean rate of traffic flow

C = typical ratio for one traffic flow

B = bandwidth requirement to maintain quality of service

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P = loss ratio

N = Number of traffic flows

15. A method of estimating the effective bandwidth as claimed in claim 14 comprising estimating a ratio D off-line for a number of traffic flows represented by:

$$D = \frac{B}{mn}$$

where B = bandwidth requirement to maintain quality of service

m = mean rate

n = maximum number of flows allowed at the node.

16. A computer program comprising program instructions for causing a computer to perform the method of claims 1 to 15.
17. A computer program according to claim 16 embodied on a recordable medium.
18. A computer program according to claim 16 embodied in a computer memory.
19. A computer program according to claim 16 embodied in a read-only memory.
20. A computer program according to claim 16 carried on an electrical carrier signal.
21. A computer program according to claim 16 carried on an optical carrier signal.
22. A system for estimating the effective bandwidth at a node in a communications network having a router associated with each node and computer hardware for monitoring traffic flow at each node comprising:-

means for identifying a type of traffic flow off-line;

characterised in that the system further comprises:-

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means for measuring an effective bandwidth and a mean rate of traffic flow of the identified type of traffic flow off-line, calculating the ratio of the effective bandwidth with respect to the mean rate of the traffic flow off-line to obtain a relationship;

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means for storing a database of relationships for different identifiable types of traffic flows off-line;

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means for identifying a type of traffic aggregate on-line at the node and measuring the mean rate of traffic aggregate of the identified type of traffic aggregate on-line;

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means for comparing the identified type of traffic aggregate on-line with the database of relationships to obtain a relationship representing the closest comparison to traffic flow off-line;

23. A system for estimating the effective bandwidth as claimed in claim 22, wherein the computer hardware comprises means to measure the mean rate of traffic flow individually on-line for a number of identifiable types of traffic flows forming a traffic aggregate.

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24. A system for estimating the effective bandwidth as claimed in claim 22, wherein the computer hardware comprises means to estimate the effective bandwidth on-line at the node for the number of identifiable types of traffic flow.

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25. A system for estimating the effective bandwidth as claimed in claims 22 to 24, wherein the database of relationships is updated with a relationship from the

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estimated effective bandwidth and the mean rate effective bandwidth on-line value for future reference.

- 5 26. A system for estimating the effective bandwidth as claimed in claims 22 to 24, wherein the computer hardware takes account of quality of service requirements when estimating the effective bandwidth at the node.
- 10 27. A system for estimating the effective bandwidth as claimed in claims 22 to 26, wherein the computer hardware incorporates a loss ratio or delay parameter when estimating the effective bandwidth at the node.
- 15 28. A system for estimating the effective bandwidth as claimed in claims 22 to 27, wherein the computer hardware calculates the relationship between the effective bandwidth and the mean rate of traffic flow calculated off-line over a number of time intervals.
- 20 29. A system for estimating the effective bandwidth as claimed in claims 22 to 28, in which the computer hardware comprises:-
a processor;
a memory storing programmed instructions; and
a bandwidth estimation server having an admission control unit and
25 storing the database of relationships.
- 30 30. A system for estimating the effective bandwidth as claimed in claim 29, wherein the computer hardware is remote from the nodes in the system.
31. A system for estimating the effective bandwidth as claimed in claim 29, in which there is provided a user interface displaying estimated bandwidths on-line for different nodes of the system.
32. A system for estimating the effective bandwidth as claimed in claim 31, in

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which the admission control unit can allocate bandwidth to certain nodes within the system in response to the displayed estimated bandwidths on-line at the nodes.

- 5 33. A computer program for the system as claimed in claims 22 to 32, for controlling the operation of the system.